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MEMORANDUM

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SUBJECT: PRELIMINARY RESULTS OF PESTICIDE RESIDUE ANALYSIS, AND
ACUTE AND CHRONIC TOXICITY TESTING OF SURFACE WATER
MONITORED IN THE SACRAMENTO RIVER WATERSHED, WINTER
2000-2001 (STUDY NUMBER 199).

SCOPE OF MEMORANDUM

The purpose of this memorandum is to provide the results of surface water sampling conducted in the Sacramento River watershed (Figures 1-3) by the Department of Pesticide Regulation (DPR) during the 2000-2001 dormant spray season. Data was collected between December 4, 2000, and March 14, 2001. Results from chemical analysis performed by the California Department of Food and Agriculture (CDFA) Center for Analytical Chemistry are presented. Samples for toxicity bioassays were collected and submitted to the California Department of Fish and Game (DFG) for analysis. The results of those analyses are presented in this memo.

The study was designed to monitor the occurrence of toxicity and dormant spray insecticides in the Sacramento River Watershed. This was the final season of a five-year study that began in 1996. Background information and monitoring results from previous studies (96-00) are available in Nordmark (1998, 1999, 2000). An in-depth interpretation of data from all five years will be provided in a final report (Spurlock, 2001).

MATERIALS AND METHODS

Study Site Description

Wadsworth Canal

The Wadsworth Canal site is located 3.5 miles above the confluence with the Sutter Bypass, at a weir, just upstream of South Butte Road (Figure 2). The location continues to flow during periods of high discharge in the bypass, and it receives runoff from the southern corner of Butte County and northern Sutter County between the Feather River and the Sutter Buttes. The area is largely agricultural with numerous orchards to the east along the Feather River. Wadsworth



Canal drains into the Sutter Bypass just above the Sutter National Wildlife Refuge and combines the flows of several streams and man-made canals. Five samples had to be collected from an alternate site at Butte House Road Bridge, 1.3 miles upstream of the primary site, due to heavy accumulation of debris at the weir or difficulty gauging discharge during very high flows. There are no inputs between the primary site and the alternate site.

Sutter Bypass

The Sutter Bypass samples were collected from a small bridge across the western channel of the Sutter Bypass at the Karnak Pumping Station, just above the Sacramento Slough (Figure 2). The Sutter Bypass receives runoff water from most of the agricultural areas between the Sacramento and Feather Rivers. Previous studies have indicated the potential for high concentrations of pesticides in surface water in this area (Wofford and Lee, 1995). All samples were collected at the primary sampling site this season.

Sacramento River

The Sacramento River samples were collected on the right bank of the river at the Alamar Marina Dock, nine miles below the confluence of the Feather River (Figure 2). The site receives discharge from all major agricultural tributaries and is above the confluence of the largely non-agricultural American River. The site is also above the urban runoff discharges from the cities of Sacramento and West Sacramento.

Sample Collection

Background sampling was conducted prior to the onset of the dormant spray season during the week of December 4, 2000. Dormant season sampling began on January 2 and continued through March 14, 2001. By the last week of the study, most almond and stone fruit trees were in bloom and the dormant spray applications were finished.

Chemical analysis was performed on samples from all three sites. Selected organophosphate and carbamate insecticides as well as selected soil applied herbicides were analyzed in three separate tests (Table 1). A fourth test was conducted to determine diazinon concentration. Insecticides included in our analyses were chosen based on pesticide use reports indicating historical use during the dormant spray season in the Central Valley, previous detections in the watershed, the availability of analytical methods in the organophosphate or carbamate screens, and to standardize analyses between the Sacramento and San Joaquin River studies. Herbicides included in our analyses were chosen based on historical use during the year in the Central Valley and the availability of analytical methods in a single screen. This season norflurazon and three breakdown products - deethyl atrazine (DEA), 2-amino-4-chloro-6-ethyl-triazine (ACET), and diaminochlorotriazine (DACT) - were added to the herbicide screen. Cyanazine was removed from the herbicide screen.

Acute toxicity tests were performed twice per week, with samples collected on Monday and Wednesday. One chronic toxicity test was conducted weekly using water samples collected on Monday, Wednesday, and Friday. Water collected on Monday was used to begin the chronic toxicity tests. Water collected on Wednesday and Friday was used to renew chronic test water.

Water samples were collected at the Alamar, Karnak and Wadsworth Canal sites, from as close to center channel as possible, using a depth-integrated sampler (D-77) with a 3-liter Teflon® bottle and nozzle.

Nine 1-liter splits were required for each sampling event. Approximately 12 liters of water were collected and composited in a stainless steel 10-gallon (38-liter) milk can. The composite sample was placed on wet ice for transportation back to the West Sacramento warehouse for splitting. All samples were split on the day of collection into 1-liter amber glass bottles, with Teflon® lined caps, using a (USGS designed) Geotech® 10-port splitter. One pair of 1-liter split samples from the Wadsworth Canal and Sacramento River sites were submitted for toxicity testing. Four 1-liter samples from each site were submitted for chemical analyses: one each for the organophosphate, carbamate, diazinon and herbicide analyses. Two 1-liter backups were stored at West Sacramento and one liter was used for acidification purposes. One additional liter was taken from the Wadsworth split and sent to a University of California, Davis, lab as part of an additional DPR project designed to compare the diazinon analytical methods, ELISA and GC/FPD. Results from the ELISA study will be presented in a separate report.

Samples designated for organophosphate and carbamate chemical analysis were preserved by acidification with 3N hydrochloric acid to a pH between 3.0 and 3.5. Most organophosphate and carbamate pesticides are sufficiently preserved at this pH (Ross et al., 1996). Diazinon, however, rapidly degrades under acidic conditions and, therefore, was analyzed from a separate, un-acidified, sample. Herbicide samples are stable without acidification and were thus not acidified. Samples were stored in a 4° C refrigerator until transported to the appropriate laboratory (on wet ice) for analysis. All primary samples were delivered to the testing laboratory within 24 hours of collection.

Environmental Measurements

Water quality parameters measured *in situ* included temperature, pH, electrical conductivity (EC), and dissolved oxygen (DO). Water pH was measured using a Sentron® (model 1001) pH meter. EC was measured using an Orion® conductivity-salinity meter (model 140). Water temperature and DO were measured using a YSI dissolved oxygen meter (model 57).

Precipitation and discharge information were gathered for the study area. Precipitation data were averaged from two sites to approximate rainfall in the Sacramento Valley. The sites were located at a Department of Forestry station near Chico and a National Weather Service station at the Sacramento Post Office (stations CHI and SPO, respectively). Discharge was measured at

the Wadsworth Canal each time a sample was collected with the exception of three dates when flow was estimated using stage height and historical flow data. Discharge from the Butte-Slough-near-Meridian (BSL) and the Tisdale Bypass (TIS) gauges were used to provide flow estimates for both Sutter Bypass sites. Discharge from the Verona U.S. Geological Survey (USGS) gauging station (VON) was used to estimate flow for the Sacramento River at Alamar Marina. The Verona site captures all major inputs to the Sacramento River above the sampling site. All precipitation and discharge data were taken from provisional, DWR, National Weather Service, USGS, and Department of Forestry information and are subject to revision. Further refinements of flow data at each site will be investigated for the final report as more information becomes available. This information will be used to follow annual changes in chemical concentrations with respect to fluctuations in flow and will also be useful for modeling efforts, should they be undertaken.

Chemical Analysis and Toxicity Testing

Chemical Analysis

Pesticide analyses of water samples were performed by the CDFA Center for Analytical Chemistry. The organophosphate insecticides were analyzed using gas chromatography (GC) and a flame photometric detector (FPD). The carbamate insecticides were analyzed using high performance liquid chromatography (HPLC), post column-derivatization, and a fluorescence detector. The herbicides were analyzed by LC/MS/MS with an APCI (Atmospheric Pressure Chemical Ionization) source. The pesticides and reporting limits are listed in Table 1. Details of chemical analytical methods will be provided in the final report.

Quality control (QC) for the chemistry portion of this study was in accordance with Standard Operating Procedure QAQC001.00 (DPR, 1996) and consisted of a continuing QC program, plus the submission of 11 rinse blanks of the splitting equipment and 29 blind spikes submitted for the Sacramento and San Joaquin studies combined. Continuing QC results for each of the analytical screens are presented in Tables 2 through 6b. Study 199 and 200 refer to the Sacramento and San Joaquin River studies, respectively. There were no detections of any pesticides in any of the 11 rinse blank samples. The 29 blind spikes, submitted along with the field samples from the two studies for analysis, contained 36 chemical analytes. More detailed quality control data, including method development, the establishment of control limits and spike recoveries, will be included in the final report.

Toxicity Bioassay

As in previous years, samples for toxicity bioassays were collected and submitted to the California Department of Fish and Game (DFG) for analysis. Acute toxicity testing was conducted by the DFG Aquatic Toxicity Laboratory following current U.S. Environmental Protection Agency (U.S. EPA) procedures using the cladoceran *Ceriodaphnia dubia* (U.S. EPA, 1993). Acute toxicity was determined using a 96-hour, static-renewal bioassay in

undiluted sample water. Chronic toxicity was determined using a static-renewal 7-day bioassay of undiluted sample water with *Ceriodaphnia dubia* and followed current U.S.EPA guidelines (U.S.EPA, 1994). Test organisms used in chronic testing were placed in sample water on day one of testing, with test water replenished on days three and five. Data were reported as percent survival for both acute and chronic tests and the average number of offspring per adult for the chronic tests. More complete information on chemical, analytical, and bioassay methods will be provided in the final report.

RESULTS

Environmental Measurements

Wadsworth Canal

Figure 6 presents the data for pH, DO, temperature, and EC for the Wadsworth Canal site. pH values ranged from 6.3 to 8.3 and water temperature from 6.9 to 15.6 °C. DO varied from 7.58 to 11.28 mg/L and EC from 194 to 578 µS/cm.

Sutter Bypass

Figure 8 presents the pH, DO, temperature, and EC data for the Sutter Bypass site. pH values ranged from 7.1 to 8.0 and water temperature from 7.0 to 15.1 °C. DO varied from 6.73 to 10.7 mg/L and EC from 184 to 399 µS/cm.

Sacramento River at Alamar

Figure 7 presents the pH, DO, temperature, and EC data for the Sacramento River site. pH values ranged from 7.1 to 8.0 and water temperature from 7.1 to 13.5 °C. DO varied from 8.6 to 11.56 mg/L and EC from 131 to 241 µS/cm.

Discharge and Precipitation

Figure 4a presents precipitation averaged for two stations in the Sacramento Valley and discharge for the Sacramento River and the Sutter Bypass. Wadsworth Canal discharge is not presented in the figure, because it is at least an order of magnitude lower than at the other two sites. Measured discharge at Wadsworth Canal is included in Table 7. All discharge data presented in Figure 4a are based on preliminary data and are approximate as all inputs and diversions were not gauged, and many gauges are not accurately calibrated at extreme flows (Nordmark, 2000). The estimated discharge in the Sutter Bypass peaked at 32,569 cubic feet per second (cfs), and the discharge in the Sacramento River at Verona peaked at 40,909 cfs. Inputs from sources such as Gilsizer Slough would increase the Sutter Bypass discharges presented here, but during high bypass flows, these inputs would be insignificant. Water did not begin flowing through the Tisdale Weir into the Sutter Bypass until February 24. Peak river and bypass levels occurred in early March. Measured discharge at Wadsworth Canal peaked at 485.5 cfs in early March. Total two-station average rainfall for the season was 13.68 inches.

Chemical Concentrations

Wadsworth Canal

Diazinon was detected in 19 of the 22 (86%) samples collected at Wadsworth Canal (Table 7). Concentrations ranged from 0.04 to 1.32 µg/L. No other organophosphates or carbamates were detected.

Herbicides were detected in 15 of 22 (68%) samples. Diuron was also detected in one background sample. Norflurazon, which was added to the herbicide screen for the first time this season, was the most commonly detected with residues in 15 of 22 samples. Concentrations ranged from 0.05 to 0.98 µg/L. Diuron was detected in 12 of 22 in-season samples, and once in the background samples, with concentrations from 0.05 to 0.291 µg/L. Simazine was detected in 6 samples at concentrations of 0.06 to 0.214 µg/L. Hexazinone was detected in 3 samples at concentrations of 0.05 to 0.263 µg/L. Bromacil was detected twice at 0.061 µg/L and 0.09 µg/L. Six of 22 (27%) samples had three or more herbicides present.

Sutter Bypass

Diazinon was detected in 9 of 22 (41%) samples (Table 7). Concentrations ranged from 0.04 to 0.132 µg/L. No other insecticides were detected.

Herbicides were detected in 16 samples (73%). Diuron was the most common, detected in 16 of the 22 samples, with concentrations ranging from 0.055 to 0.115 µg/L. Norflurazon was detected four times, bromacil three times, and simazine twice. Concentrations of the three ranged from 0.05 to 0.116 µg/L.

Sacramento River

Diazinon was detected once at 0.048 µg/L (Table 8). No other insecticides were detected.

Herbicide residues were detected in 27 of 31 (87%) samples. Diuron was the most common, found 27 times at concentrations from 0.05 to 1.42 µg/L. Detections of diuron began on January 10 and were found in all subsequent samples but one. Bromacil was detected 4 times at concentrations from 0.05 to 0.5 µg/L. Simazine was detected twice and norflurazon was detected once.

Toxicity Results

Acute Toxicity

Seven of the 24 samples had statistically significant reductions in survival (Table 7). Complete mortality was observed in 3 of the samples. Diazinon was detected in 6 of the 7 samples that had

significant mortality. Diazinon was also detected in 13 samples that did not show significant mortality.

Chronic Toxicity

No samples had significant mortality (Table 8). Two samples had significant differences in number of offspring. The only analyte detected in those two samples was diuron at 0.06 and 0.17 µg/L.

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Table 1. California Department of Food and Agriculture, Center for Analytical Chemistry organophosphate and carbamate insecticide and triazine herbicide screens for the Sacramento River toxicity monitoring study.

Organophosphate Pesticides in Surface Water by GC Method: GC/FPD		N-Methyl Carbamate in Surface Water by HPLC Method: HPLC/Post Column-fluorescence		Herbicides in Surface Water Method: APCI LC/MS/MS	
Compound	Reporting Limit (µg/L)	Compound	Reporting Limit (µg/L)	Compound	Reporting Limit (µg/L)
Chlorpyrifos	0.04	Carbaryl	0.05	Atrazine	0.05
Diazinon ¹	0.04	Carbofuran	0.05	Bromacil	0.05
Dimethoate (Cygon)	0.05			Diuron	0.05
Fonofos	0.05			Norflurazon	0.05
Malathion	0.05			Hexazinone	0.05
Methidathion	0.05			Metribuzin	0.05
Methyl parathion	0.05			Prometon	0.05
Phosmet	0.05			Prometryn	0.05
				Simazine	0.05
				DEA, ACET, DACT ²	0.05

¹ Diazinon was analyzed from a separate, unpreserved, split sample. Other OP and CB chemical samples were preserved with 3N HCl to a pH of 3-3.5 to retard analyte degradation. See text. ² DEA= deethyl atrazine ACET= 2-amino-4- chloro-6-ethyl-triazine DACT= diaminochlorotriazine

Table 2. Blind Spike Recoveries for the San Joaquin River and Sacramento River Studies.

Extraction Date	Study Number ^a	Sample Number	Screen	Pesticide	Spike Level	Recovery	Percent Recovery	Exceed CL ^b
1/9/01	200	158	Triazine	Atrazine	0.30	0.260	86.7	
				DEA	0.30	0.320	107	UWL
1/11/01	199	104	Organophosphate	Chlorpyrifos	0.30	0.286	95.3	
1/11/01	199	106	Diazinon	Diazinon	0.30	0.256	85.3	
1/12/01	199	105	Carbamate	Carbofuran	0.35	0.291	83.1	
1/16/01	199	107	Triazine	Prometon	0.40	0.315	78.8	
1/16/01	200	87	Diazinon	Diazinon	0.30	0.252	84.0	
1/16/01	200	85	Organophosphate	Dimethoate	0.20	0.16	80.0	
1/16/01	200	86	Carbamate	Carbaryl	0.25	0.237	94.8	
1/19/01	200	88	Triazine	DACT	0.50	0.427	85.4	
1/18/01	200	101	Organophosphate	Phosmet	0.30	0.422	141	UCL
1/18/01	199	146	Diazinon	Diazinon	0.20	0.151	101	^c
1/18/01	200	102	Diazinon	Diazinon	0.20	0.173	86.5	^c
1/18/01	199	145	Organophosphate	Chlorpyrifos	0.30	0.291	97.0	
1/23/01	200	137	Organophosphate	Methidathion	0.30	0.36	120	UWL
2/8/01	200	331	Triazine	Bromacil	0.20	0.20	100	
				DEA	0.20	0.18	90.0	
2/8/01	200	328	Organophosphate	Fonofos	0.30	0.289	96.3	
2/15/01	199	472	Triazine	Prometon	0.30	0.292	97.3	
				simazine	0.50	0.646	129	UCL
2/16/01	199	470	Carbamate	Carbaryl	0.25	0.239	95.6	
				Carbofuran	0.30	0.261	87.0	
2/15/01	199	471	Diazinon	Diazinon	0.20	0.176	88.0	
2/15/01	199	469	Organophosphate	Dimethoate	0.30	0.414	138	UCL
				Phosmet	0.20	0.318	159	UCL
2/21/01	200	259	Carbamate	Carbaryl	0.30	0.279	93.0	
2/20/01	200	260	Diazinon	Diazinon	0.25	0.213	85.2	
2/20/01	200	261	Triazine	ACET	0.30	0.26	86.7	
				DACT	0.25	0.21	84.0	
2/20/01	200	258	Organophosphate	Chlorpyrifos	0.25	0.249	99.6	
				Methidathion	0.25	0.256	102	
2/27/01	199	404	Diazinon	Diazinon	0.25	0.23	92.0	
2/27/01	199	402	Organophosphate	Methidathion	0.25	0.287	115	
2/28/01	199	403	Carbamate	Carbaryl	0.20	0.188	94.0	
2/26/01	199	405	Triazine	Atrazine	0.20	0.16	80.0	
3/16/01	200	338	Triazine	Norflurazon	0.25	0.22	88.0	

^a 199 refers to the study number for the Sacramento River, 200 refers to the SJR.

^b CL=Control Limit; Upper CL (UCL), Lower CL (LCL). CLs for these pesticides are listed in Tables 3 through 6.

^c Blind spike duplicates. Percent difference is 15.4.

Table 3. Continuing Quality Control- Organophosphate Screen

Extraction Date	Sample Numbers	Percent Recovery						
		Dimethoate	Fonofos	Methyl Parathion	Malathion	Chlorpyrifos	Methidathion	Phosmet
12/7/00	199-1,7,13 and 200-1,7	110	98	104	97	107	111	119
12/11/00	199-19,25,36,37 and 200-13,19,25	114	103	108	104	113	121	122
1/3/01	199-37,43,55 and 200-31	91	104	102	93	107	112	124
1/5/01	199-61,67,73 and 200-43,49	92	102	97	89	103	105	119
1/9/01	199-79,85,91 and 200-55,61	106	80	97	89	77	100	116
1/11/01	199-97,104,108,114 and 200-87,73	95	94	102	98	100	102	102
1/16/01	199-120,126,132,139 and 200-79,85,99,95	111	97	106	110	90	120	133
1/18/01	199-145,147,154,160, and 200-101,103,109	99.9	99.2	103	101	102	104	108
1/23/01	199-168,172,178,183,189 and 200-115,121,125,131,137	105	101	110	107	106	107	109
1/30/01	199-214,220,224,231,237 and 200-150,160,166	84.8	81.5	87.3	85.4	85.0	88.5	78.6
2/1/01	199-243,250,254,260 and 200-172,178	89.4	91.2	93.9	97.3	96.0	95.6	96.2
2/6/01	199-226,272,279,285 and 200-184,190,198,199	79.3	79.0	84.0	85.2	84.1	88.7	90.7
2/8/01	199-291,298,304 and 200-208,212,328	89	84.2	88	89	90.3	90	92
2/13/01	199-310,316,322,329 and 200-218,224,230	87.6	81.1	88.1	90.7	89.0	91.8	93.8
2/15/01	199-335,342,348,(469) and 200-236,242	83.7	86.2	87	89.1	87.5	91	90.8
2/20/01	199-354,360,364,370,377 and 200-248,254,(268),262,268	85.7	72.7	83.2	87.4	85.5	89.1	90.0
2/22/01	199-383,390,396 and 200-274,280	87.3	77.9	86.6	89.1	87.8	88.9	92.0
2/27/01	199-(402),406,412,419,423,429 and 200-286,292,298	92.7	89.1	91.3	94.3	93.8	96.9	95.9
3/2/01	199-435,442,448 and 200-304,310	89.5	89.3	93.2	93.2	91.9	92.0	92.4
3/6/01	199-454,460,467,479 and 200-316,322,326,332	104	94.2	103	105	101	107	98.8
3/8/01	199-485,492,498 and 200-339,345	86.5	91.2	90.0	93.0	92.4	92.5	89.0
3/12/01	199-539,545 and 200-351	93.4	95.8	94.6	98.9	97.9	99.0	99.5
3/15/01	199-549,556,562,571,577,583 and 591	79.0	85.3	88.2	87.5	112	88.4	83.8
Average Recovery		93.7	90.2	95.0	94.5	95.6	99.1	101.4
Standard Deviation		9.5	8.8	7.8	7.1	9.3	9.8	13.9
CV		10.16	9.80	8.22	7.51	9.73	9.84	13.70
Upper Control Limit		116	102	116	114	116	124	118
Upper Warning Limit		110	100	110	109	110	116	113
Lower Warning Limit		86	94	85	87	83	83	95
Lower Control Limit		80	92	79	81	76	75	90

*Highlighted cells are percent recoveries exceeding control limits

Study 199 is the dormant season monitoring on the Sacramento River, Study 200 in the San Joaquin River

Table 4. Continuing Quality Control-
Carbamate Screen

Extraction Date	Sample Numbers	Percent Recovery	
		Carbofuran	Carbaryl
12/6/00	199-2,8,14 and 200-2,8	98.8	99.8
12/11/00	199-20,26,35,38 and 200-14,20,26	85.2	90.6
1/4/01	199-44,50,56 and 200-32,38	87.5	93.2
1/8/01	199-62,68,74 and 200-44,50	91.4	96.4
1/10/01	199-80,86,92 and 200-58,62	94.0	101.0
1/12/01	199-98,105,109,115 and 200-68,74	83.8	99.1
1/17/01	199-121,127,133,140, and 200-80,86,90,96	88.2	97.9
1/22/01	199-148,155,161,167,173, and 200-104,110,116,122	79.9	91
1/24/01	199-177,184,190 and 200-126,132	90.3	91.2
1/25/01	199-196,203,209 and 200-139,145	79.0	89.4
1/31/01	199-215,221,225,232,238 and 200-151,161,167	95.3	103
2/2/01	199-244,251,255,261 and 200-173,179	79.1	87.6
2/7/01	199-267,273,280,286 and 200-185,191,194,201	91.6	94.8
2/9/01	199-292,299,305 and 200-207,213	92.4	97.7
2/14/01	199-311,317,323,330 and 200-219,225,231	87.8	93.6
2/16/01	199-336,343,349,470 and 200-237,243	93.6	99.0
2/21/01	199-355,361,365,371,378 and 249,255,259,263,269	96.7	101
2/28/01	199-403,407,413,420, 424,430 and 200-287,293,299	87.5	97.3
3/5/01	199-436,443,449,455 and 200-305,311,317,323	96.0	103
3/7/01	199-461,468,480 and 200-327,333	103	102
3/9/01	199-486,493,499 and 200-340,346	105	107
3/13/01	199-540,548,550, 557,563 and 200-352	100	101
3/16/01	199-572,578,584,592	84.6	100
Average Recovery		90.9	97.3
Standard Deviation		7.24	5.02
CV		7.97	5.16
Upper Control Limit		102	108
Upper Warning Limit		96.5	103
Lower Warning Limit		76.8	83.1
Lower Control Limit		71.8	78.1

*Highlighted cells are percent recoveries exceeding control limits

Study 199 is the dormant season monitoring on the Sacramento River, Study 200 is the San Joaquin River

Table 5. Continuing Quality Control-
Diazinon Analysis

Extraction Date	Sample Numbers	Percent Recovery
		Diazinon
12/7/00	199-3,9,15 and 200-3,9	106.1
12/11/00	199-21,27,34 and 200-15,21,27	103.1
1/3/01	199-45,51,57 and 200-33,39	93.8
1/8/01	199-63,69,75 and 200-45,51	92.5
1/9/01	199-81,87,93 and 200-48,57,63	97.5
1/12/01	199-99,106,110,116 and 200-69,75	92.8
1/16/01	199-122,128,134,141 and 200-81,87,91,97	79.7
1/18/01	199-146,149,156,162 and 200-102,105,111	99.4
1/23/01	199-168,174,178,185,191 and 200-117,123,127,133	86.8
1/25/01	199-197,204,210 and 200-140,141	83.8
1/30/01	199-216,222,226,233,239 and 200-152,162,168	78.6
2/1/01	199-245,252,262 and 200-174,180	89.6
2/6/01	199-268,274,281,287 and 200-186,192,196,202	85.1
2/8/01	199-293,300,306 and 200-205,214	96.5
2/13/01	199-312,318,324,331 and 200-220,226,232	87.9
2/15/01	199-337,344,250,471 and 200-238,244	95.3
2/20/01	199-356,362,366,372,379 and 200-250,256,260,264,270	81.4
2/27/01	199-(404),408,414,421, 425,431 and 200-288, 294,300	88.0
3/6/01	199-437,444,450,456, 462,475,481	88.0
3/6/01	200-306,312,318,324, 328,334	90.3
3/8/01	199-487,494,535 and 200-341,347	96.4
3/12/01	199-541,547 and 200-353	84.1
3/14/01	199-551,558,564	89.7
3/16/01	199-573,579,585,593	99.4
Average Recovery		91.1
Standard Deviation		7.2
CV		7.95
Upper Control Limit		109
Upper Warning Limit		103
Lower Warning Limit		77.6
Lower Control Limit		71.4

Table 6a. Continuing Quality Control- Triazine/Diuron/Bromacil Screen (Duc's)

Extraction Date	% Recovery													Propazine (Surrogate)
	Atra-zine	Sim-azine	Diuron	Prom-eton	Brom-acil	Prom-etryn	Hexaz-inone	Cyan-azine	Metri-buzin	Norflur-azon	DEA (Deethyl)	ACET (Deiso)	DACT	
1/4/01 - Spike 1	69.0	75.0	79.5	68.0	78.5	71.0	75.0	72.0	81.5	76.5	76.0	85.5	70.0	64.5
1/4/01 - Spike 2	79.0	76.0	83.5	78.0	89.5	79.5	84.0	78.5	90.5	84.0	84.0	81.0	78.0	78.0
1/5/01 - Spike 1	69.0	74.5	83.0	69.0	83.5	70.0	82.0	75.0	75.0	81.0	72.0	84.0	69.0	68.0
1/5/01 - Spike 2	77.5	80.5	96.0	76.5	87.0	76.5	85.0	83.0	91.0	87.0	81.5	92.5	77.0	77.0
1/19/01- Spike 1	75.5	70.5	90.0	70.0	83.5	71.0	69.0	75.5	77.5	81.0	82.0	83.0	73.0	68.5
1/19/01- Spike 2	79.5	79.5	94.5	70.5	89.0	71.5	75.5	81.0	84.5	88.0	88.5	94.5	80.5	74.5
1/25/01- Spike 1	81.0	69.9	73.0	68.0	92.0	65.5	72.0	79.0	83.0	83.0	90.5	111.0	91.0	77.5
1/25/01- Spike 2	93.0	73.5	90.0	78.0	100.5	71.5	79.5	89.0	92.5	95.0	95.0	113.5	98.5	84.0
2/1/01-Spike 1	85.0	80.5	87.0	71.5	91.0	81.5	81.0	83.0	87.0	83.0	86.0	86.5	73.5	83.5
2/1/01-Spike 2	79.0	81.0	92.5	69.0	89.5	80.5	73.0	75.0	74.0	82.5	86.5	88.0	66.5	76.0
2/5/01-Spike 1	71.5	65.0	87.5	68.0	81.0	69.0	69.5	73.0	77.0	76.5	78.0	80.5	70.5	68.0
2/5/01-Spike 2	72.0	69.5	80.5	68.0	86.5	89.5	76.5	77.0	76.0	79.0	78.0	83.5	75.0	72.0
2/6/01-Spike 1	83.0	79.5	87.5	77.0	92.0	82.5	88.5	87.5	89.5	88.0	87.0	85.5	74.0	81.5
2/6/01-Spike 2	81.0	83.0	75.5	76.5	93.0	79.5	84.5	87.5	89.5	88.0	88.0	98.5	81.0	77.0
2/13/01- Spike 1	81.5	74.5	102.0	79.0	92.5	81.0	86.5	82.5	97.5	87.0	84.5	88.0	72.5	81.0
2/13/01- Spike 2	80.0	72.5	106.0	76.0	90.0	77.0	79.0	81.0	89.0	86.0	86.0	89.0	69.5	76.0
2/15/01- Spike 1	92.0	100.0	86.5	91.0	103	91.0	91.5	89.0	95.0	96.5	96.5	107	102	86.0
2/15/01- Spike 2	89.5	103.5	88.5	90.0	101.5	93.0	88.5	96.5	91.5	95.0	95.5	110	107	86.0
2/22/01 - Spike 1	79.5	76.5	101.5	77.0	91.0	78.5	79.5	89.0	89.5	83.0	87.0	95.0	78.5	80.5
2/22/01 - Spike 2	89.0	83.5	98.0	85.5	93.0	84.0	86.5	98.0	88.0	90.0	91.5	98.0	89.7	87.0
3/1/01 - Spike 1	69.5	69.5	89.0	71.5	76.0	71.0	79.5	77.0	81.0	79.5	76.5	87.0	77.5	67.4
3/1/01 - Spike 2	72.5	70.5	83.5	73.5	87.0	73.5	85.0	88.0	82.0	84.0	76.5	83.5	84.5	69.5
3/8/01 - Spike 1	72.5	71.0	82.0	68.5	79.0	70.0	78.5	77.5	80.0	80.0	76.0	81.5	77.5	68.5
3/8/01 - Spike 2	81.0	73.5	97.5	77.0	90.5	75.0	86.5	87.5	80.0	87.0	83.5	98.0	76.0	76.5
3/13/01 - Spike 1	74.5	73.0	82.0	77.0	84.0	71.0	85.0	77.0	72.5	88.0	80.0	93.5	75.0	70.0
3/13/01 - Spike 2	76.0	79.5	72.5	79.0	91.0	75.0	85.5	84.0	77.5	88.5	86.0	108.5	86.0	74.5
3/15/2001- Spike 1	79.0	74.0	106.5	98.5	94.0	76.0	101.0	90.5	97.0	93.5	87.0	85.0	76.5	82.0
3/15/2001Spike 1	81.0	78.0	96.5	99.0	94.0	78.0	99.0	86.0	92.5	94.5	88.0	87.5	77.0	82.0
Average Recovery	79.0	77.1	89.0	76.8	89.4	76.2	82	82.8	85.1	85.9	84.6	92.1	79.5	76.3
Standard Deviation	6.60	8.4	9.2	8.78	6.49	6.54	7.70	6.82	7.30	5.60	6.33	9.96	9.95	6.50
CV	8.35	10.8	10.4	11.43	7.26	8.58	9.34	8.23	8.58	6.52	7.48	10.81	12.52	8.51
Upper Control Limit	105	108	118	106	117	111	121	162	110	113	116	140	101	115
Upper Limit	98.2	101	109	99.2	111	105	113	144	103	107	109	128	95.7	107
Lower Limit	72.2	73.2	73.4	73.8	84.9	78.9	76.9	70.9	75.0	84.8	79.1	78.3	73.7	72.4
Lower Control Limit	65.8	66.3	64.4	67.4	78.4	72.4	68.1	52.7	68.0	79.2	71.7	66.0	68.2	63.8

*Highlighted cells are percent recoveries exceeding control limits

Table 6b. Continuing Quality Control- Triazine/Diuron/Bromacil Screen (Pam's)

Extraction	% Recovery												
Date	Atrazine	Sim-azine	Diuron	Prom-eton	Brom-acil	Prome-tryn	Hexaz-inone	Metri-buzin	Norflur-azon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
12/12/00-Spike 1	75.5	83.5	84.5	80.5	88.0	82.5	71.5	87.0	92.5	88.0	82.0	90.0	78.5
12/12/00-Spike 2	83.0	91.0	129	88.5	101	90.0	87.0	101	104	94.0	90.5	101	86.5
12/28/00 - Spike 1	80.0	83.5	99.0	80.0	97.5	88.0	107.0	87.0	97.5	89.0	80.5	86.5	78.5
12/28/00 - Spike 2	88.0	85.5	127	96.0	102	99.5	125	96.5	126	97.0	95.0	99.5	85.0
1/9/01-Spike 1	79.0	91.0	119	81.5	104	95.0	92.5	82.5	99.0	95.5	104.0	81.5	76.0
1/9/01-Spike 2	88.5	95.0	114	104	105	105	106	93.0	103	105	108	95.0	88.5
1/16/01-Spike 1	73.5	72.0	92.0	71.0	81.0	76.5	68.5	76.5	81.5	78.0	87.5	72.5	76.5
1/16/01-Spike 2	74.5	74.5	87.0	69.0	85.0	72.5	68.5	74.5	78.5	78.0	81.0	76.0	73.5
1/23/01-Spike 1	83.5	92.5	112	98.0	101	99.5	91.0	90.5	109.5	99.5	101	97.5	87.0
1/23/01-Spike 2	99.5	99.5	116	107	103	110	111	98.0	121.5	105	111.0	103.0	93.0
1/29/01-Spike 1	79.0	85.5	95.5	84.0	82.5	89.5	77.5	88.0	98.0	90.0	89.0	81.5	79.0
1/29/01-Spike 2	77.5	73.5	80.5	79.5	91.5	81.0	76.0	81.5	87.0	84.0	81.5	75.0	75.5
2/2/01-Spike 1	77.0	80.0	92.5	78.5	94.0	78.5	75.5	82.5	92.5	86.0	95.5	96.0	73.0
2/2/01-Spike 2	84	85	109	84.5	102	88	87.5	89	103	95.5	101	112	79.5
2/8/01-Spike 1	86	91.5	113	81.5	93.5	82.0	89.0	92.5	99.0	93.5	93.5	93.0	82
2/8/01-Spike 2	82.5	89.0	106	89.0	89.0	85.0	88.5	91.5	109	95.5	89.0	103	85.0
2/26/01 - Spike 1	74.0	78.5	97.0	84.5	79.5	89.0	97.0	85.0	99.0	83.5	83.0	86.5	77.0
2/26/01 - Spike 2	78.5	82.0	113	90.0	94.0	93.5	101	88.5	98.5	88.0	85.5	88.5	86.5
2/27/01 - Spike 1	77.0	88.5	106	90.5	88.5	91.5	99.0	92.5	100	90.0	92.5	89.0	80.0
2/27/01 - Spike 2	87.0	89.5	116	93.0	94.0	93.5	99.0	98.5	105	89.0	90.0	93.0	83.0
4/24/01-Spike 1	97.0	89.5	86.0	87.0	95.5	90.0	89.5	85.5	98.5	92.0	86.0	90.0	83.5
4/24/01-Spike 2	79.5	83.0	81.0	88.0	89.5	83.5	90.5	87.5	95.0	92.0	87.5	93.5	83.5
Average Recovery	82.0	85.6	103.3	86.6	93.6	89.3	91	88.6	99.8	91.3	91.6	91.0	81.4
Standard Deviation	6.91	7.0	14.5	9.25	7.63	9.11	14.39	6.73	10.82	7.10	8.81	9.84	5.23
CV	8.43	8.2	14.1	10.68	8.15	10.21	15.85	7.60	10.84	7.78	9.62	10.81	6.43
Upper Control Limit	107	108	147	112	129	110	112	119	126	111	121	105	114
Upper Warning Limit	100	101	134	105	119	103	104	110	118	105	112	99	107
Lower Warning Limit	71.5	74.2	81.1	75.8	80.6	74.9	72.4	73.1	85.9	77.9	76.7	74.9	76.3
Lower Control Limit	64.4	67.5	68.0	68.6	70.9	68.0	64.5	64.0	77.9	71.3	67.9	68.9	68.7

*Highlighted cells are percent recoveries exceeding control limits

Table 7. Results of sampling at Wadsworth Canal and the Sutter Bypass, Winter 2000-2001. Only pesticides detected at the site during this sampling season are shown.

Wadsworth Canal							
Sampling Date	Diazinon (µg/L)	Bromacil (µg/L)	Diuron (µg/L)	Hexazinone (µg/L)	Norflurazon (µg/L)	Simazine (µg/L)	Acute Tox. % Survival Sample/Control
4-Dec	nd ¹	nd	0.05	nd	nd	nd	100/100
6-Dec	nd	nd	nd	nd	nd	nd	65/100
2-Jan	0.059	nd	nd	nd	nd	nd	80/100
4-Jan	0.053	nd	nd	nd	nd	nd	90/100
8-Jan	1.32	nd	0.26	nd	0.98	0.19	0/100*
10-Jan	0.085	nd	0.194	nd	0.18	nd	85/100
15-Jan	0.067	nd	0.054	nd	0.107	nd	95/95
17-Jan	0.042	nd	0.06	nd	0.10	nd	70/100*
22-Jan	0.04	nd	nd	nd	nd	nd	95/100
24-Jan	0.185	nd	nd	nd	0.05	nd	95/100
29-Jan	0.065	nd	nd	nd	nd	nd	100/100
31-Jan	0.049	nd	nd	nd	nd	nd	65/95
5-Feb	nd	nd	nd	nd	nd	nd	85/100
7-Feb	nd	nd	nd	nd	nd	nd	100/100
12-Feb	0.536	0.09	0.291	0.263	0.252	0.214	0/100*
14-Feb	0.164	nd	0.07	0.079	0.186	0.092	90/90
19-Feb	0.119	nd	0.06	nd	0.09	nd	95/100
21-Feb	0.154	0.061	0.109	nd	0.171	0.105	100/100
26-Feb	0.289	nd	0.1	nd	0.15	0.06	5/100*
28-Feb	0.049	nd	0.05	nd	0.063	nd	50/95
5-Mar	0.393	nd	0.07	0.05	0.21	0.14	0/95*
7-Mar	0.064	nd	0.18	nd	0.113	nd	90/100
12-Mar	nd	nd	nd	nd	0.053	nd	75/100*
14-Mar	0.067	nd	nd	nd	0.05	nd	70/100*

Sutter Bypass				
Diazinon (µg/L)	Bromacil (µg/L)	Diuron (µg/L)	Norflurazon (µg/L)	Simazine (µg/L)
nd	nd	nd	nd	nd
nd	nd	nd	nd	nd
nd	nd	nd	nd	nd
nd	nd	nd	nd	nd
nd	nd	nd	nd	nd
nd	0.115	0.156	nd	nd
nd	nd	0.154	0.05	nd
nd	nd	0.06	nd	nd
nd	nd	0.069	nd	nd
nd	nd	0.08	nd	nd
0.058	nd	0.055	nd	nd
0.045	nd	0.07	nd	nd
0.049	nd	nd	nd	nd
0.04	nd	nd	nd	nd
nd	nd	0.066	nd	nd
0.107	0.057	0.107	0.087	0.065
nd	nd	0.16	nd	nd
nd	nd	0.099	nd	nd
0.132	nd	0.26	0.05	nd
0.056	nd	0.11	nd	nd
0.05	nd	0.09	nd	nd
0.052	0.053	0.269	0.052	0.116
nd	nd	nd	nd	nd
nd	nd	0.073	nd	nd

Notes for Tables 7 and 8.

¹ nd= none detected at the reporting limit for that chemical.

* The difference in survival between the sample and the control was significant at p< 0.05 n=4

Table 8. Results of sampling for the Sacramento River at Alamar Marina, Winter 2000-2001. Only pesticides detected at the site during this sampling season are shown.

Sacramento River

Sampling Date	Diazinon (µg/L)	Bromacil (µg/L)	Diuron (µg/L)	Norflurazon (µg/L)	Simazine (µg/L)	Chronic Toxicity % Survival Sample/Control	Chronic Toxicity Offspring Sample/Control
4-Dec	nd ¹	nd	nd	nd	nd	100/100	41.0/23.9
6-Dec	nd	nd	nd	nd	nd		
8-Dec	nd	nd	nd	nd	nd		
2-Jan	nd	nd	nd	nd	nd	NST	
4-Jan	nd	nd	nd	nd	nd		
8-Jan	nd	nd	nd	nd	nd	90/100	14.3/17.6
10-Jan	nd	nd	0.281	nd	nd		
12-Jan	nd	0.09	0.389	0.055	nd		
15-Jan	nd	0.05	0.313	nd	0.056	90/80	25.5/18.0
17-Jan	nd	nd	0.21	nd	nd		
19-Jan	nd	nd	0.09	nd	nd		
22-Jan	nd	nd	0.06	nd	nd	80/100	14.1/22.9*
24-Jan	nd	nd	0.05	nd	nd		
26-Jan	nd	nd	0.06	nd	nd		
29-Jan	0.048	nd	0.196	nd	0.056	100/90	31.8/16.5
31-Jan	nd	nd	0.21	nd	nd		
2-Feb	nd	nd	0.1	nd	nd		
5-Feb	nd	nd	0.062	nd	nd	100/90	21.4/18.2
7-Feb	nd	nd	0.08	nd	nd		
9-Feb	nd	nd	nd	nd	nd		
12-Feb	nd	nd	0.26	nd	nd	80/90	32.6/16.8
14-Feb	nd	0.5	1.282	nd	nd		
16-Feb	nd	nd	0.32	nd	nd		
19-Feb	nd	nd	0.15	nd	nd	100/100	35.6/21.5
21-Feb	nd	nd	0.301	nd	nd		
23-Feb	nd	nd	1.42	nd	nd		
26-Feb	nd	nd	0.43	nd	nd	80/100	19.7/19.2
28-Feb	nd	nd	0.251	nd	nd		
2-Mar	nd	nd	0.16	nd	nd		
5-Mar	nd	nd	0.17	nd	nd	60/90	6.5/21.7*
7-Mar	nd	nd	0.17	nd	nd		
9-Mar	nd	0.056	0.156	nd	nd		
12-Mar	nd	nd	0.254	nd	nd	NST	
14-Mar	nd	nd	0.825	nd	nd		

Notes for Table 8.

¹ nd= none detected at the reporting limit for that chemical.

NST= No samples taken for week

* Difference in offspring/animal between sample and control significant at p<0.05, n=4



Figure 1. Map of the Sacramento River Hydrologic Basin.

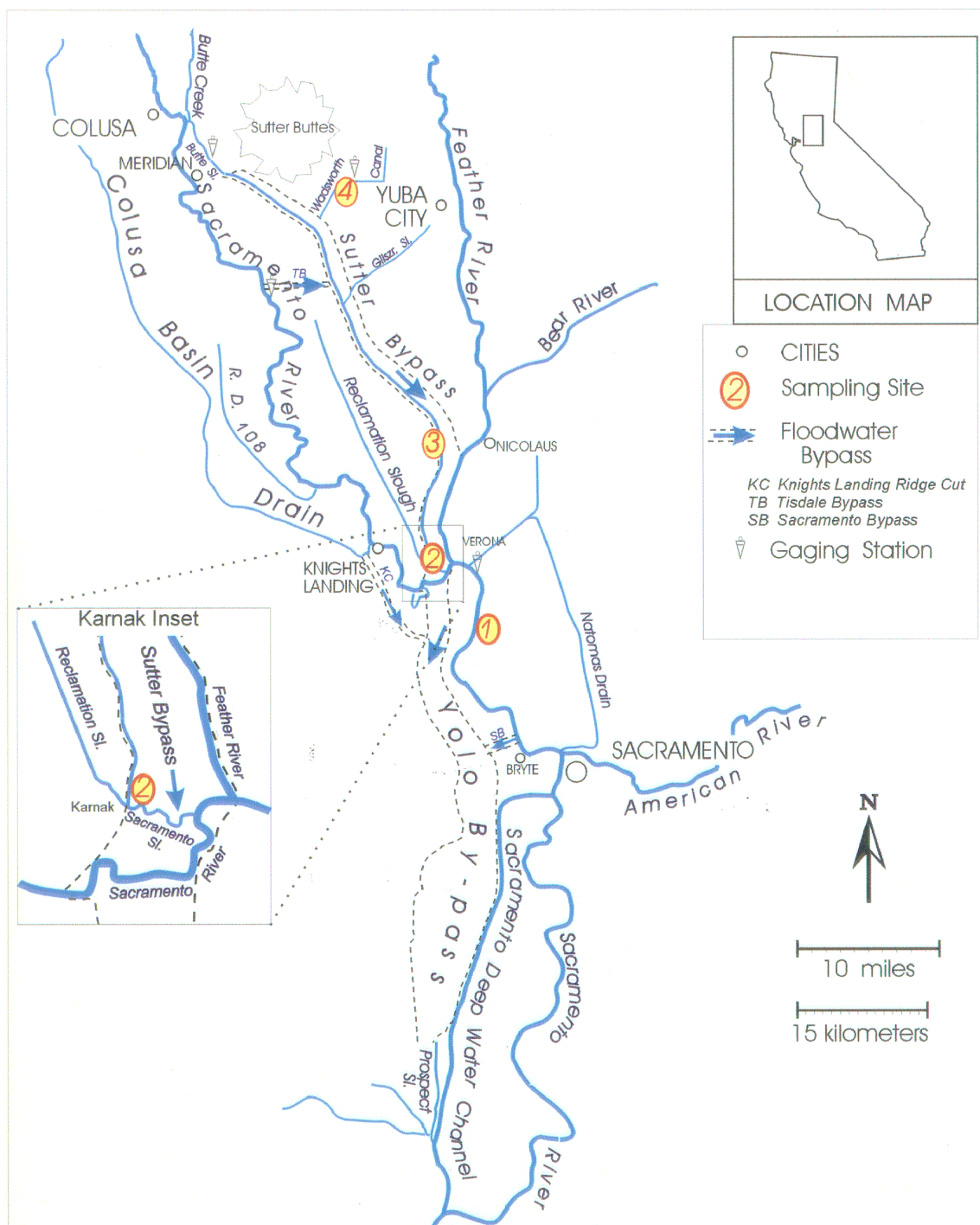


Figure 2: Sampling sites in the Sacramento River watershed.
 Site 1 = Alamar Marina, Sacramento River Chronic Toxicity Site.
 Site 2 = Sutter Bypass at Karnak Pumping Station, Water Chemistry Site.
 Site 3 = Sutter Bypass at Kirkville Road, Alternate Water Chemistry Site.
 Site 4 = Wadsworth Canal, Acute Toxicity Monitoring Site.

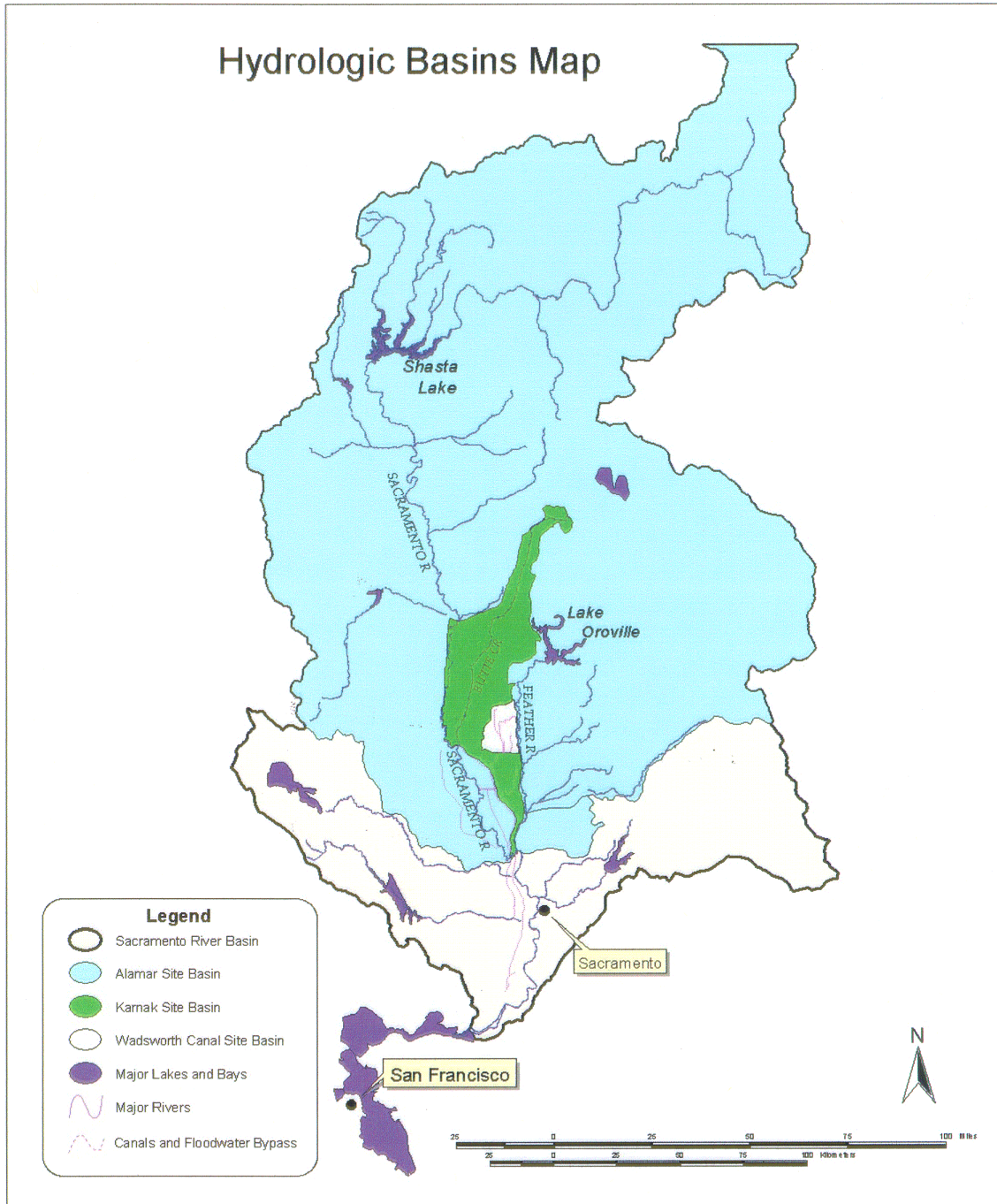


Figure 3. Map of the Hydrologic Basins for the sites used for the 1999-2000 Dormant Spray Monitoring. Each basin includes the area of all the basins listed below it in the legend. When the alternate site at Kirkville Road is used, the hydrologic basin would include large areas of the "Alamar Basin" above Butte Creek due to the influx of Sacramento River water into the Sutter Bypass at Butte Creek and the Tisdale Weir.

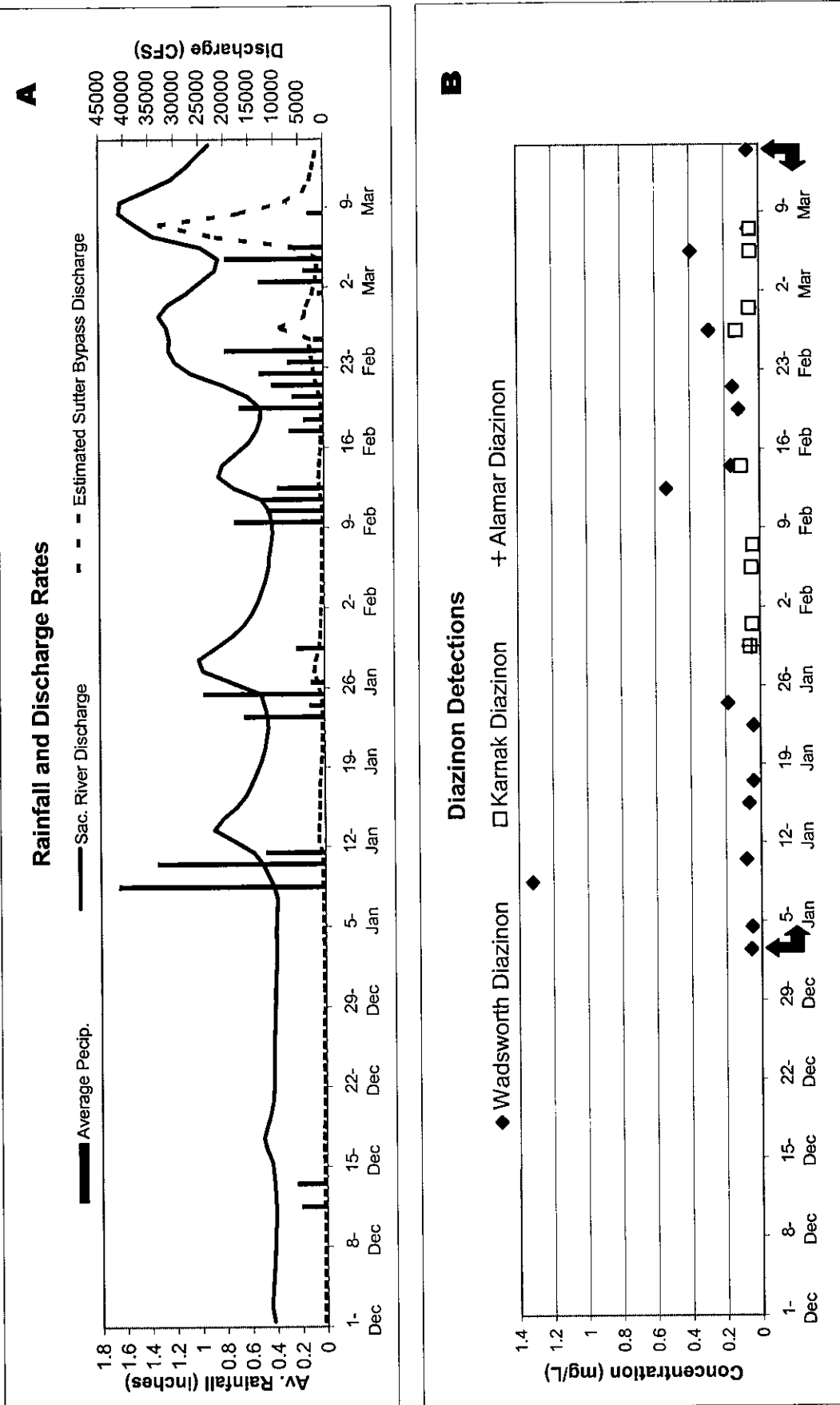


Figure 4. (A) Daily Rainfall and discharge for the Sacramento River and the Sutter Bypass from December 1, 2000 through March 15, 2001. Rainfall data is an average of Sacramento Post office and Chico weather stations. Sacramento River discharge was measured at Verona. Sutter Bypass discharge was estimated by adding discharges from the Butte Slough near Meridian and the Tisdale Bypass gages. Rainfall and discharge data are provisional and subject to revision. (B) Diazinon detections for Wadsworth Canal, Sutter Bypass, and the Sacramento River at Alamar. Data collected between January 2 and March 14, 2001.

Herbicide Detections

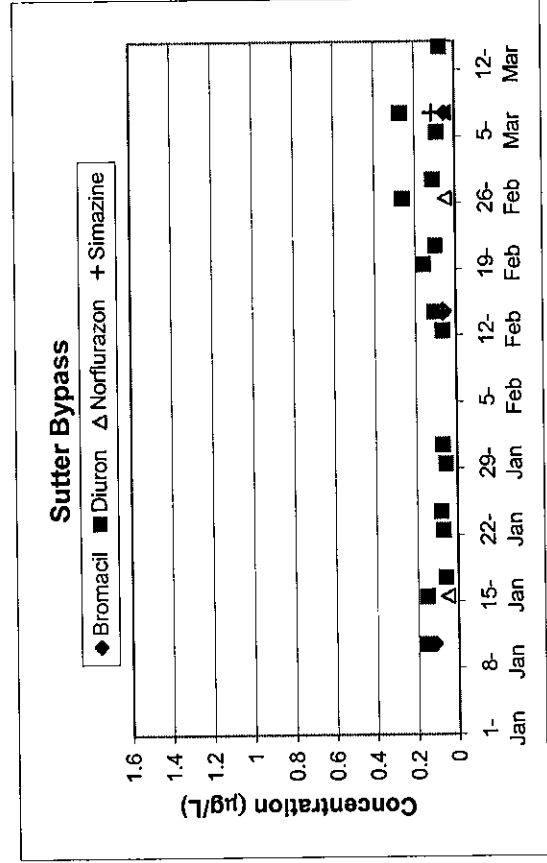
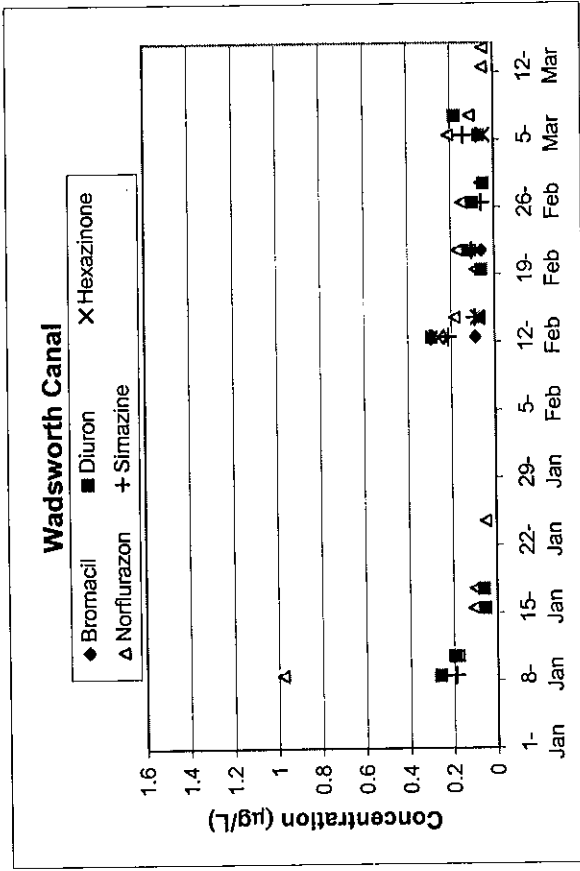
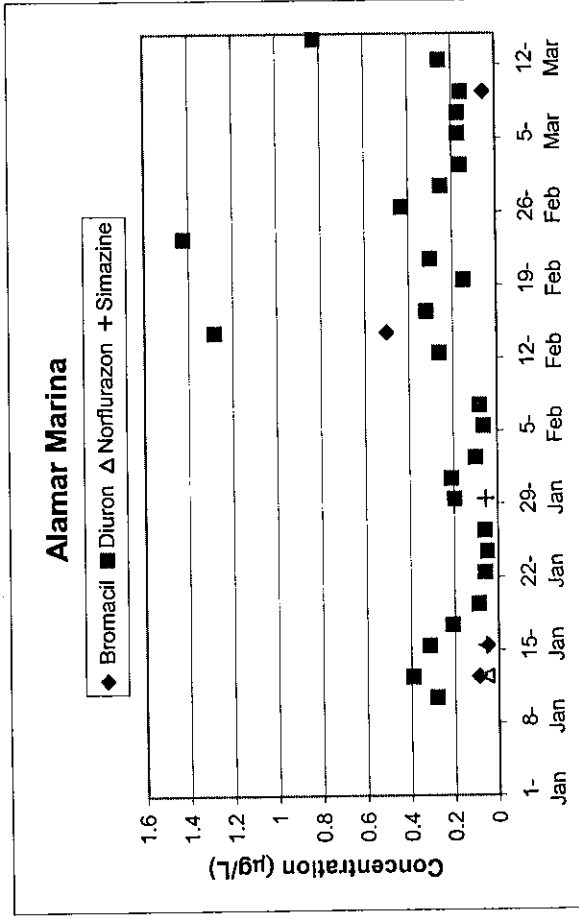


Figure 5. Detected herbicide concentrations for the Sacramento River at Alamar Marina, Wadsworth Canal, and the Sutter Bypass at the Kamak Pumping Station. Data collected from January 2 through March 14, 2001.

Environmental Data For Wadsworth Canal, Winter 2000-2001

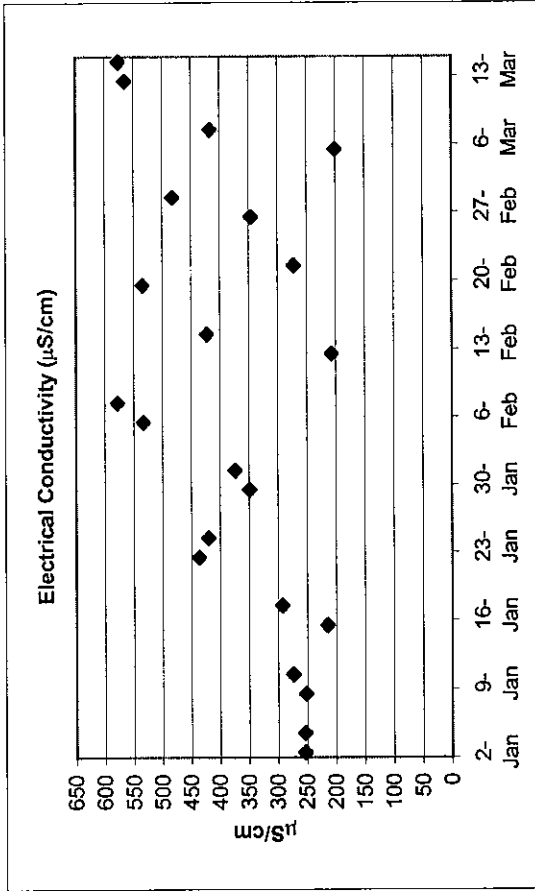
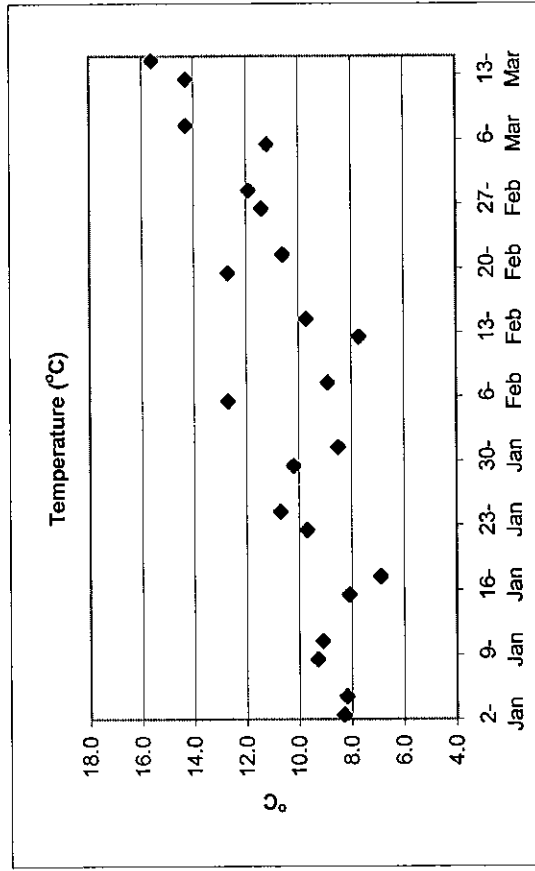
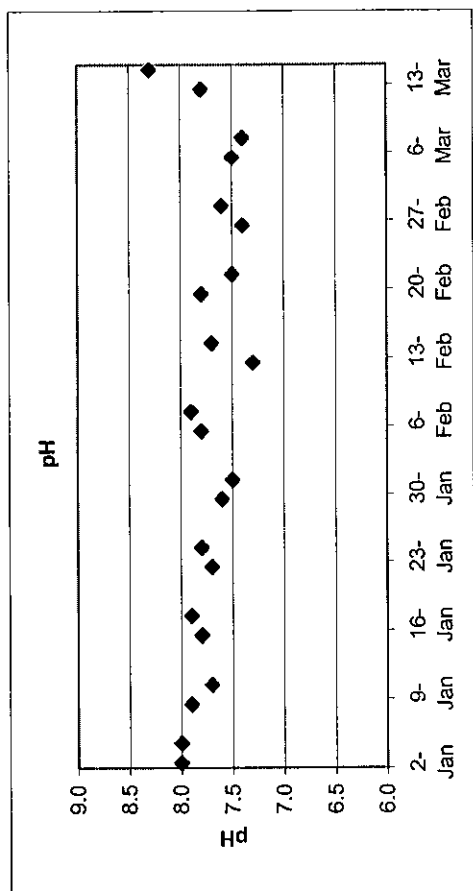
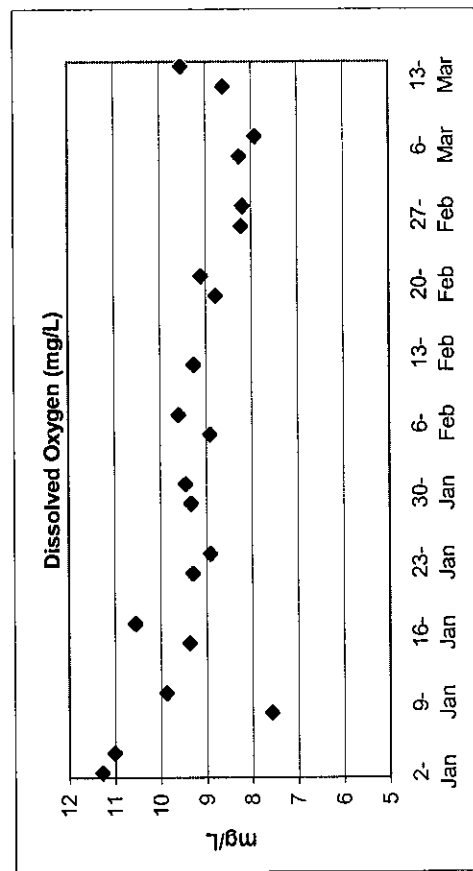


Figure 6. Environmental measurements taken at Wadsworth Canal. Measurements were taken between January 2 and March 14, 2001.

Environmental Data For The Sacramento River, Winter 2000-2001

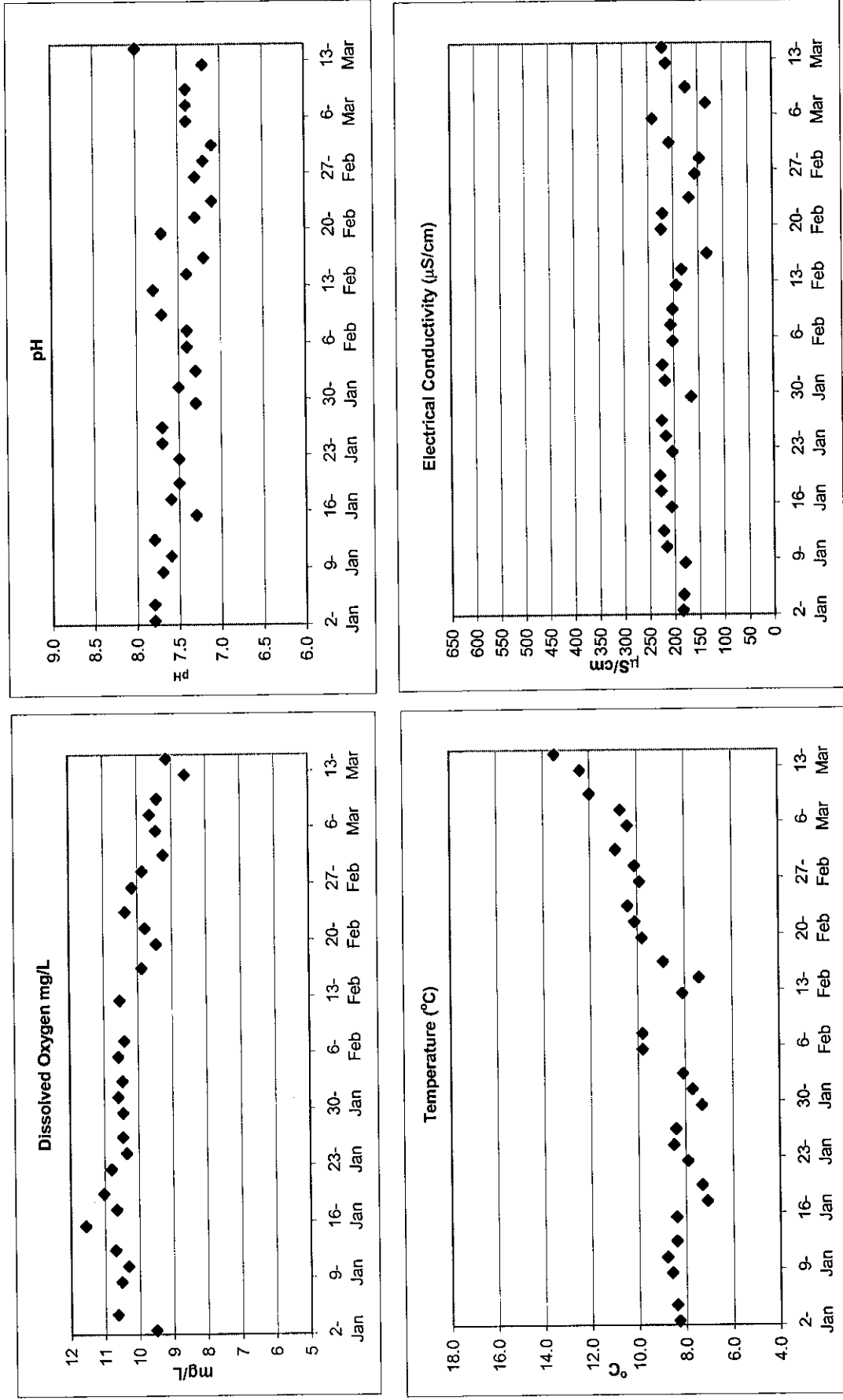


Figure 7. Environmental measurements taken for the Sacramento River at the Alamar Marina. Measurements were taken between January 2 and March 14, 2001.

Environmental Data For Sutter Bypass, Winter 2000-2001

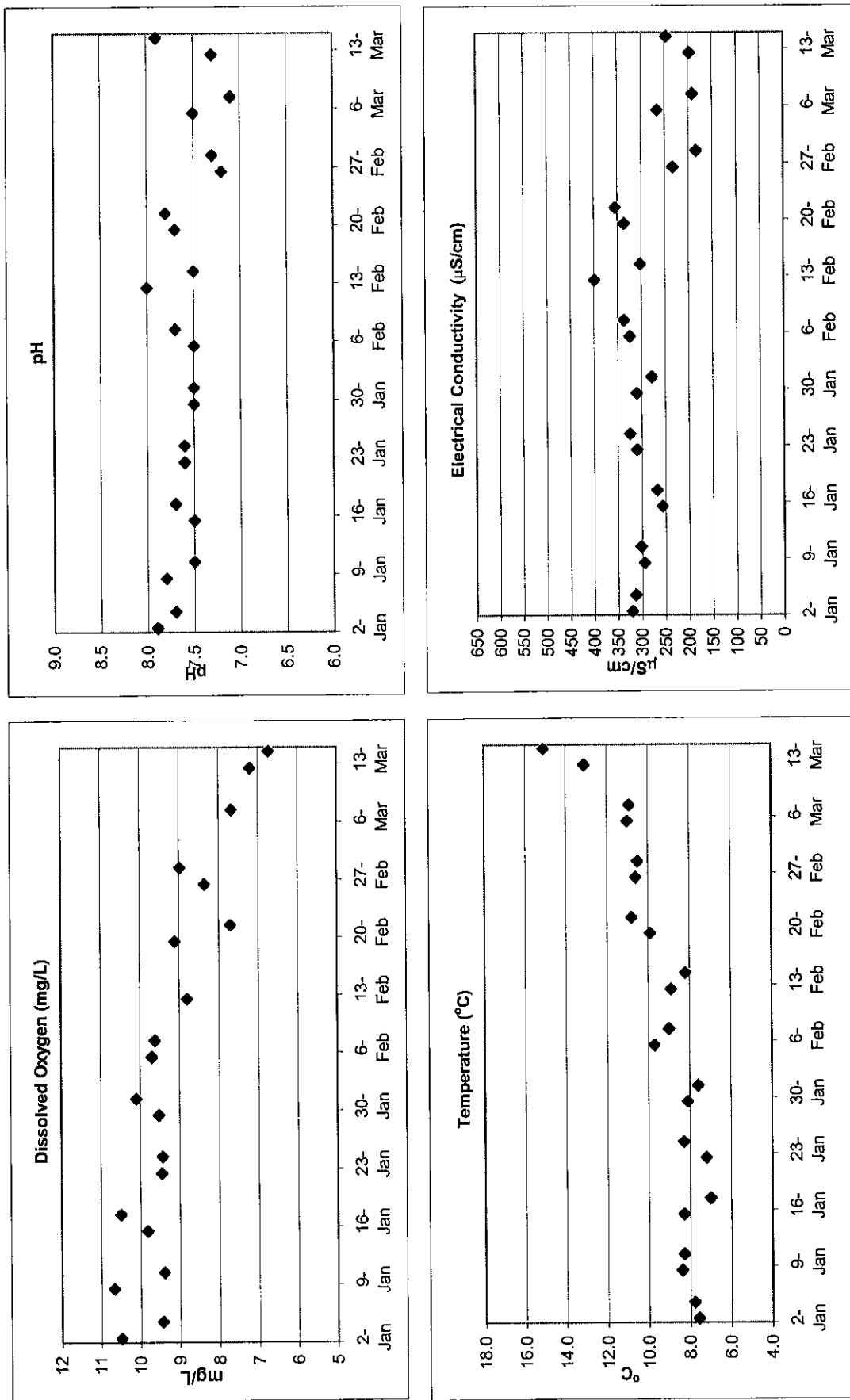


Figure 8. Environmental measurements taken for the Sutter Bypass at the Karnak Pumping Station. Measurements were taken between January 2 and March 14, 2001.

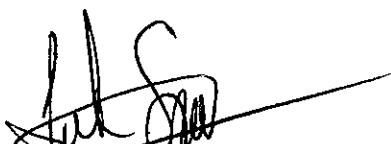


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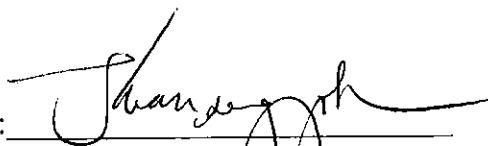
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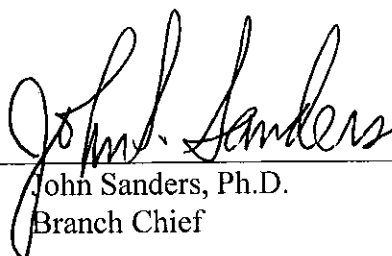
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